CLAIMS

WHAT IS CLAIMED IS:

1. A method for mapping radio-frequency noise comprising the steps of:

providing a frame containing radio-frequency amplitude data, the frame comprising a plurality of time bins;

sampling radio-frequency amplitude data from the frame;

identifying a plurality of corresponding time bins in the frame;

averaging the radio-frequency amplitude data in the corresponding time bins;

determining an absolute value of a difference from adjacent time bin radio-frequency amplitude averages, thereby obtaining a change in adjacent time bin radio-frequency amplitude averages; and

determining an absolute value of a difference of the change in adjacent time bin radio-frequency amplitude averages, thereby obtaining a rate of change in adjacent time bin radio-frequency amplitude averages.

2. The method for mapping radio-frequency noise of claim 1, wherein the sampled radio-frequency amplitude data is stored in matrix form, and a plurality of frames are sampled, so that each frame comprises a row, and the corresponding time bins comprise one or more columns.

3. The method for digitally mapping radio-frequency noise of claim 2, wherein the matrix comprises:

$$S = \begin{bmatrix} A(f_0 t_0) & A(f_0 t_1)......A(f_0 t_n) \\ A(f_1 t_0) & A(f_1 t_1)......A(f_1 t_n) \\ . & \\ A(f_{N-1} t_0) & A(f_{N-1} t_1)...A(f_{N-1} t_n) \\ A(f_N t_0) & A(f_N t_1)......A(f_N t_n) \end{bmatrix}$$

where matrix S contains a plurality of radio-frequency amplitude data samples, A is a discrete radio-frequency amplitude sample, f represents the frame number and t represents the time bin of the discrete radio frequency amplitude sample.

4. The method for digitally mapping radio-frequency noise of claim 3, wherein averaging the radio-frequency amplitude samples A in corresponding time bins t_i from the plurality of frames f_j is performed by taking column-wise averages of matrix S according to the following equation:

$$\overline{M1}_i = \frac{1}{N+1} \sum_{j=0}^{N} A(f_j t_i),$$

thereby obtaining a plurality of radio-frequency amplitude averages $\overline{M1}$ of the corresponding time bins t_i of each frame f_j.

5. The method for digitally mapping radio-frequency noise of claim 4, wherein determining an absolute value of a difference from adjacent time bin radio-frequency amplitude averages $\overline{M2}_i$ is performed according to the following equation:

$$\overline{M2_i} = \left|\overline{M1_{i+1}} - \overline{M1_i}\right|,$$

where $\overline{M1_i}$ is obtained from claim 4.

6. The method for digitally mapping radio-frequency noise of claim 5, wherein determining an absolute value of a difference of the change in adjacent time bin radio-frequency amplitude averages $\overline{M3_i}$ is performed according to the following equation:

$$M3_i = \left|M2_{i+1} - M2_i\right|,$$

where $M2_i$ is obtained from claim 5.

7. The method for mapping radio-frequency noise of claim 1, further including the step of:

ranking the radio-frequency noise by evaluating one or more of:

the plurality of radio-frequency amplitude averages of the corresponding time bins of each frame;

the change in adjacent time bin radio-frequency amplitude averages; and

the rate of change in adjacent time bin radio-frequency amplitude averages.

8. The method for mapping radio-frequency noise of claim 1, further including the step of:

assigning a data transmission rate to one or more UWB communication channels, each UWB communication channel comprising a plurality of time bins.

9. The method for mapping radio-frequency noise of claim 8, wherein the data transmission rate for each UWB communication channel is based on the radio-frequency noise present in the channel time bins.

10. The method for mapping radio-frequency noise of claim 1, wherein a time period of each frame varies with a number of UWB communication channels present in the frame.

11. The method for mapping radio-frequency noise of claim 1, further including the step of inserting time bins into a frame to avoid detected radio-frequency noise.

12. The method for mapping radio-frequency noise of claim 1, wherein a duration of a time bin can range from about 40 picoseconds to about 100 nanoseconds.

13. A method for mapping radio-frequency noise comprising the steps of:

providing a plurality of frames containing radio-frequency amplitude data, each frame comprising a plurality of time bins;

sampling radio-frequency amplitude data from the plurality of frames;

identifying a plurality of corresponding time bins in each of the plurality of frames;

determining a difference between the radio-frequency amplitude in the corresponding time bins in successive frames, thereby obtaining a change in the radio-frequency amplitude in corresponding time bins across successive frames; and

determining a difference between the change in the radio-frequency amplitude in corresponding time bins across successive frames, thereby obtaining a rate of change in the radio-frequency amplitude in corresponding time bins across successive frames.

14. The method for mapping radio-frequency noise of claim 13, wherein the sampled radio-frequency amplitude data is stored in matrix form, so that each frame comprises a row, and corresponding time bins comprise one or more columns.

15. The method for mapping radio-frequency noise of claim 14, wherein the matrix comprises

$$S = \begin{bmatrix} A(f_0 t_0) & A(f_0 t_1) \ldots\ldots A(f_0 t_n) \\ A(f_1 t_0) & A(f_1 t_1) \ldots\ldots A(f_1 t_n) \\ \cdot & \\ A(f_{N-1} t_0) & A(f_{N-1} t_1) \ldots A(f_{N-1} t_n) \\ A(f_N t_0) & A(f_N t_1) \ldots\ldots A(f_N t_n) \end{bmatrix}$$

where matrix S contains a plurality of radio-frequency amplitude data samples, A is a discrete radio-frequency amplitude sample, f represents the frame number and t represents the time bin.

16. The method for mapping radio-frequency noise of claim 15, wherein determining a difference between the radio-frequency amplitude samples A in the corresponding time bins t_i in successive frames f_j, is obtained according to the following equation:

$$M4_{ji} = \left|A(f_{j+1}t_i) - A(f_j t_i)\right|,$$

thereby obtaining a change in the radio-frequency amplitude A in corresponding time bins t_i across successive frames f_j.

17. The method for mapping radio-frequency noise of claim 16, wherein determining a difference between the change in the radio-frequency amplitude A in corresponding time bins t_i across successive frames f_j, is obtained by values obtained in claim 16 according to the following equation:

$$M5_{ji} = \left|M4_{i+1} - M4_i\right|,$$

thereby obtaining a rate of change in the radio-frequency amplitude A in corresponding time bins t_i across successive frames f_j.

18. The method for mapping radio-frequency noise of claim 13, further including the step of:

ranking the radio-frequency noise by evaluating one or more of:

the plurality of radio-frequency amplitude averages of the corresponding time bins across successive frames;

the change in corresponding time bin radio-frequency amplitude averages across successive frames; and

the rate of change in corresponding time bin radio-frequency amplitude averages across successive frames.

19. The method for mapping radio-frequency noise of claim 13, further including the step of:

assigning a data transmission rate to one or more UWB communication channels, each UWB communication channel comprising a plurality of time bins.

20. The method for mapping radio-frequency noise of claim 19, wherein the data transmission rate for each UWB communication channel is based on the radio-frequency noise present in the channel time bins.

21. The method for mapping radio-frequency noise of claim 13, wherein a time period of each frame varies with a number of UWB communication channels present in the frame.

22. The method for mapping radio-frequency noise of claim 13, further including the step of inserting time bins into a frame to avoid detected radio-frequency noise.

23. The method for mapping radio-frequency noise of claim 13, wherein a duration of a time bin can range from about 40 picoseconds to about 100 nanoseconds.

24. A method for mapping radio-frequency noise in a multi-channel ultra-wideband communication system, the method comprising the steps of:

pseudo-randomly placing a plurality of time bins within a plurality of time frames;

assigning a plurality of channels comprising selected pseudo-randomly placed time bins;

sampling radio-frequency amplitude data from the selected pseudo-randomly placed time bins; and

averaging the radio-frequency amplitude data from the selected pseudo-randomly placed time bins, thereby obtaining an average radio-frequency amplitude in each of the plurality of channels.

25. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, further comprising the step of:

determining an absolute value of a difference between the radio-frequency amplitude average in the corresponding time bins in each of the plurality of channels, thereby obtaining a change in the radio-frequency amplitude average in corresponding time bins across successive channels.

26. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 25, further comprising the step of:

determining an absolute value of a difference of the change in the radio-frequency amplitude average in corresponding time bins across successive channels, thereby obtaining a rate of change in the radio-frequency amplitude average in corresponding time bins across successive channels.

27. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, wherein the sampled radio-frequency amplitude data is stored in matrix form, so that each frame comprises a row, and the pseudo-randomly placed time bins comprise one or more columns.

28. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 27, wherein the matrix comprises:

$$S = \begin{bmatrix} A(f_0 t_0) & A(f_0 t_1) \ldots\ldots A(f_0 t_b) \\ A(f_1 t_0) & A(f_1 t_1) \ldots\ldots A(f_1 t_b) \\ . & \\ A(f_{N-1} t_0) & A(f_{N-1} t_1) \ldots A(f_{N-1} t_b) \\ A(f_N t_0) & A(f_N t_1) \ldots\ldots A(f_N t_b) \end{bmatrix}$$

where matrix S contains a plurality of radio-frequency amplitude data samples, and A is a discrete radio-frequency amplitude sample, f represents the frame number and t represents the pseudo-randomly placed time bin.

29. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 28, wherein averaging the radio-frequency amplitude data from selected pseudo-randomly placed time bins is performed according to the following equation:

$$\overline{M6_j} = \frac{1}{N+1}\sum_{j=0}^{N}\sum_{k=1}^{b} A(f_j t_k),$$

where f_j is frame j, t_k is the k^{th} time slot allocated to the same channel in frame f_j, k is a pseudo-noise sequence of time bins b, and N is the number of frames over which the sequence is averaged, thereby obtaining an average radio-frequency amplitude in each of the plurality of channels.

30. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 29, wherein determining an absolute value of a difference between the radio-frequency amplitude average in the corresponding time bins in each of the plurality of channels, is performed according to the following equation:

$\overline{M7_j} = \left|\overline{M6_l} - \overline{M6_k}\right|$, where $M6_l$ is a time bin that follows $M6_k$ in a sequence of pseudo-randomly placed time bins allocated to a UWB communication channel;

thereby obtaining a change in the radio-frequency amplitude average in corresponding time bins across successive channels,

31. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 30, wherein determining an absolute value of a

difference of the change in the radio-frequency amplitude average in corresponding time bins across successive channels, is performed according to the following equation:

$\overline{M8_j} = \left|\overline{M7_l} - \overline{M7_k}\right|$, where $M7_l$ is a time bin that follows $M7_k$ in a sequence of pseudo-randomly placed time bins allocated to a UWB communication channel;

thereby obtaining a rate of change in the radio-frequency amplitude average in corresponding time bins across successive channels.

32. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, wherein time bins are randomly allocated by a pseudo-random time bin generator.

33. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, further including the step of:

ranking the radio-frequency noise in a plurality of ultra-wideband communication channels by evaluating one or more of:

the plurality of radio-frequency amplitude averages in each of the plurality of ultra-wideband communication channels;

a change in the radio-frequency amplitude averages in corresponding time bins across successive ultra-wideband communication channels; and

the rate of change in the radio-frequency amplitude averages in corresponding time bins across successive ultra-wideband communication channels.

34. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, further including the step of:

assigning a data transmission rate to one or more UWB communication channels.

35. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 34, wherein the data transmission rate for each UWB communication channel is based on the radio-frequency noise present in the channel time bins.

36. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of 24, wherein a time period of each frame varies with a number of UWB communication channels present in the frame.

37. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, further including the step of inserting time bins into a frame to avoid detected radio-frequency noise.

38. The method for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 24, wherein a duration of a time bin can range from about 40 picoseconds to about 100 nanoseconds.

39. A method for estimating channel quality in a multi-channel ultra-wideband communication system, the method comprising the steps of:

pseudo-randomly placing a plurality of time bins within a plurality of time frames, each time bin comprising one or more data bits;

assigning a plurality of channels comprising selected pseudo-randomly placed time bins;

transmitting a multiplicity of data bits through the plurality of channels;

monitoring the number of data bits transmitted through each channel;

determining a number of data bit errors in the transmissions;

determining a projected bit error rate for at least one transmission; and

grading a channel quality using at least the projected bit error rate.

40. The method for estimating channel quality in a multi-channel ultra-wideband communication system of claim 39, wherein determining a projected bit error rate for at least one transmission is obtained iteratively through the following equation:

$$PBER = -\frac{\ln(1-CL)}{n} + \frac{\ln\left(\sum_{k=0}^{N}\frac{(n \cdot PBER)^k}{k!}\right)}{n}$$

where *PBER* is a projected value of the bit error rate, *n* is the number of bits transmitted, *CL* is a confidence level, *N* is the total number of bit errors that occur during the transmission, and *k* refers to a k^{th} bit error.

41. The method for estimating channel quality in a multi-channel ultra-wideband communication system of claim 40, wherein the confidence level *CL* is a statistical confidence that the bit error rate will be less than or equal to the projected bit error rate.

42. A system for mapping radio-frequency noise in a multi-channel ultra-wideband communication system comprising:

logic for pseudo-randomly placing a plurality of time bins within a plurality of time frames;

logic for assigning a plurality of channels comprising selected pseudo-randomly placed time bins;

logic for sampling radio-frequency amplitude data from the selected pseudo-randomly placed time bins; and

logic for averaging the radio-frequency amplitude data from the selected pseudo-randomly placed time bins, thereby obtaining an average radio-frequency amplitude in each of the plurality of channels.

43. The system for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 42, further comprising:

logic for determining an absolute value of a difference between the radio-frequency amplitude average in the corresponding time bins in each of the plurality of channels, thereby obtaining a change in the radio-frequency amplitude average in corresponding time bins across successive channels.

44. The system for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 43, further comprising:

logic for determining an absolute value of a difference of the change in the radio-frequency amplitude average in corresponding time bins across successive channels,

thereby obtaining a rate of change in the radio-frequency amplitude average in corresponding time bins across successive channels.

45. The system for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 42, wherein time bins are randomly allocated by a pseudo-random time bin generator.

46. The system for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 42, further including:

logic for ranking the radio-frequency noise in a plurality of ultra-wideband communication channels by evaluating one or more of:

the plurality of radio-frequency amplitude averages in each of the plurality of ultra-wideband communication channels;

a change in the radio-frequency amplitude averages in corresponding time bins across successive ultra-wideband communication channels; and

the rate of change in the radio-frequency amplitude averages in corresponding time bins across successive ultra-wideband communication channels.

47. The system for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 42, further including:

logic for assigning a data transmission rate to one or more UWB communication channels.

48. The system for mapping radio-frequency noise in the multi-channel ultra-wideband communication system of claim 57, wherein the data transmission rate for each UWB communication channel is based on the radio-frequency noise present in the channel time bins.